NISTIR 5704

EMISS
A Program for Estimating Local Air Pollution Emission Factors Related to Energy Use in Buildings

User's Guide and Reference Manual

Stephen R. Petersen
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Gaithersburg, Maryland 20899

Sponsored by:
The Federal Energy Management Program
U.S. Department of Energy
Washington, DC 20585

United States Department of Commerce
Technology Administration
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ABSTRACT

EMISS is a computer program used to generate data files with regional or local air pollution emission factors for use with the NIST BLCC (Building Life-Cycle Cost) program. BLCC uses these emission factors to calculate air pollution emissions associated with energy use in buildings and reductions in those emissions attributable to energy conservation measures. Three types of emission factors are currently included in EMISS data files: carbon dioxide, sulfur dioxide, and nitrous oxide. Emission factors are specified separately for six different end-use energy types: electricity, distillate and residual fuel oil, natural gas, liquid petroleum gas (LPG), and coal. Emission factors for fossil fuels can be regionalized or localized by specifying the percentage of sulfur in the fuel, the heating content of the fuel, and the end-use combustion process at the building site. A data base with state-specific electricity emission factors and U.S. average sulfur content of fossil fuels provides default data for use in setting up a regional or local emission factors file. EMISS is intended for use on an IBM or compatible PC running under DOS.

Note: This software was produced by the National Institute of Standards and Technology (NIST), an agency of the U.S. government, and by statute is not subject to copyright in the United States. Recipients of this software assume all responsibility associated with its operation, modification, maintenance, and subsequent re-distribution.

PREFACE

The NIST BLCC (Building Life-Cycle Cost) computer program provides comprehensive economic analysis of proposed capital investments that are expected to reduce long-term operating costs of buildings or building systems. BLCC is the standard reference program for the U.S. Department of Energy's Federal Energy Management Program (FEMP). As such, it is used to evaluate the cost effectiveness of alternative energy conservation investments in federal buildings. However, it can be used by state and local governments and by the private sector as well for establishing the relative cost effectiveness of alternative buildings and building systems.

BLCC also provides computations of reductions in air pollution emissions related to these conservation investments in buildings and building systems. BLCC computes reductions in CO_2, SO_2, and NO_x emissions based on the building's use of electricity, distillate and residual fuel oils, natural gas, LPG, and coal. Reductions in these emissions are reported in kilograms per year and kilograms over the life-cycle of the building system being evaluated. However, no dollar amounts are placed on these emission reductions; rather, they are reported as additional information that may be of use when selecting among alternative buildings or building systems.

The calculation of reductions in air pollution emissions by BLCC is based on emission factors generated by EMISS or provided as input to EMISS. Default emission factors for electricity are provided in the data base file that is distributed with the EMISS program. Default data on the sulfur content and heating value of fossil fuels, and NO_x factors as a function of the end-use combustion process, are also provided in this data base file, based on national average data. The user is encouraged to modify these default values to reflect local fuel usage conditions. As a result, the quality of the emission factors generated by EMISS is ultimately dependent on the user's knowledge of the factors which contribute to these emissions.

The continued development and support of EMISS, BLCC, and related economic decision-support software at NIST has been sponsored by FEMP. Federal agencies and contractors can obtain copies of this software free of charge from Advanced Sciences, Inc. of Arlington, VA, (703) 243-4900. Others interested in obtaining more information on these software products can call the Office of Applied Economics, Building and Fire Research Laboratory, NIST (301) 975-6132.

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1. Introduction

1.1 Overview

EMISS is a special-purpose computer program for use in generating data files with location-specific emission factors for CO_2, SO_2, and NO_x, related to energy usage in buildings. These emission factors are generated for electricity, distillate and residual fuel oils, natural gas, LPG, and coal. The resulting data files can be accessed by the NIST BLCC (Building Life-Cycle Cost) computer program to calculate reductions in air pollution emissions attributable to energy conservation investments in buildings and building systems. The BLCC program is a decision-support software tool for use in the life-cycle cost analysis of energy conservation measures for new buildings and modifications to existing buildings. BLCC does not place an explicit dollar value on these reduced emissions, but the additional information on the emission reductions themselves may prove useful to decision makers in selecting among alternative building systems.

With EMISS, you can enter location-specific fuel characteristics and end-use data needed to generate emission factors representative of a particular region or location. You can also enter and edit emission factor files directly if appropriate emission factors are available. Emission factor files can be generated at the national, regional, state, or local level, as appropriate to the analysis. These emission factor files are saved to the disk, usually to the subdirectory where the BLCC program is located. The files can generally be used over a long period of time without change as long as the underlying emission factors do not change.

A data base file with default data used to generate emission factors is included with the EMISS program. The name of this data file is EMISS.FIL. The format of this file is documented in appendix A. When using EMISS to generate emission factors, location-specific data can be substituted for the default data from EMISS.FIL. The heating value (energy content per unit of fuel) and sulfur content (percent by weight) factors representative of the fuel used at the building site can be used instead of the default values, which are based on national average data. The emission factor for NO_x requires specification of the type of end-use combustion equipment used in the building.

The default emission factors for electricity provided in EMISS.FIL are based on the average mix of fossil-fired generation facilities (coal, oil, and natural gas) in the region or state indicated. Emissions from fossil-fired generation facilities are used instead of averages for all generation facilities because conservation measures will more likely result in reductions in electrical generation from fossil-fired facilities, which have higher variable generation costs, than from nuclear and hydroelectric facilities, which have lower variable generation costs. These emission factors and their derivation are provided in section 4 on Documentation. SO_2 factors for electricity generation require a table of yearly scalars which represent the anticipated reductions in SO_2 emissions (per kWh of output) as a result of increasing environmental controls on electricity generation over time. Default data for these scalar factors are also retrieved from EMISS.FIL. The derivation of these scalars is also provided in section 4.

Table 1-1 shows energy- and emissions-related sections from a detailed LCC summary report generated by BLCC for a specific building in a given operating environment. The types of energy used in the building, relevant units, price per unit, and number of units used annually are specified by the user for a base-case building (or building system) design and for alternative building (or system) designs. The user also specifies the name of the data file from which the mission factors are to be imported. The emission factors are used by BLCC to convert the annual energy usage amounts to equivalent emission amounts in kilograms and are reported by fuel type and in total in the detailed LCC summary report.

Table 1-1. Energy usage data, related costs, and emissions summary from LCC report

ENERGY-RELATED COSTS

Energy Type	Units	Units/ Year	Price+ ($/Unit)	Annual Cost Energy	Annual Cost Demand	Total P.V. Cost
Electricity	kWh	10,000	$0.100	$1,000	$500	$18,920
Distil. Oil	Gallon	2,000	$1.000	$2,000	$0	$27,026
Natural Gas	Therm	3,000	$1.000	$3,000	$0	$39,526

+Price and annual cost are as of base date (not adjusted for price escalation).

EMISSIONS SUMMARY \a

Energy Type	Annual Emissions	Life-cycle Emissions \b
Electricity:		
CO2 (kg):	5,808.9	116,178
SOx (kg):	48.8	496
NOx (kg):	24.9	498
Distil. Oil:		
CO2 (kg):	20,310.7	406,214
SOx (kg):	28.0	560
NOx (kg):	16.8	336
Natural Gas:		
CO2 (kg):	15,843.0	316,860
SOx (kg):	0.1	2
NOx (kg):	12.0	240
Total:		
CO2 (kg):	41,962.6	839,252
SOx (kg):	76.9	1,058
NOx (kg):	53.7	1,074

\a Based on emission factors from file USAVG.EMI.
\b Life-cycle emissions are the sum of all emissions over the designated study period, adjusted for reductions in SO_2 emissions over time and for indexed energy usage where appropriate. The designated study period is shown in the full report.

Table 1-2 shows the energy savings and emissions reduction summaries from a BLCC comparative analysis report. (The reductions in life-cycle costs, reported in the comparative analysis, are not shown here.) The comparative analysis report compares the economic and energy performance of two building design (or building system) alternatives and shows the annual energy savings and reductions in air pollution emissions by energy type. The comparative analysis report accesses the energy usage and emissions data from the LCC analysis of each of two alternative designs and subtracts one from the other to estimate reductions (or, in some cases, increases) in annual energy use and emissions. As with the detailed LCC report, reductions in emissions are shown for each fuel type used (in kilograms) and in total.

Table 1-2. Energy savings and emissions reduction summary from BLCC

ENERGY SAVINGS SUMMARY

Energy type	Units	Annual Consumption			Life-Cycle Savings
		Base Case	Alternative	Savings	
Electricity	kWh	10,000	8,500	1,500	30,000
Distil. Oil	Gallon	2,000	1,750	250	5,000
Natural Gas	Therm	3,000	2,500	500	10,000

EMISSIONS REDUCTION SUMMARY

Energy type	Annual Emissions		Annual Reduction	Life-Cycle Reduction
	Base Case	Alternative		
Electricity:				
CO2 (kg):	5,808.9	4,937.5	871.3	17,426.7
SOx (kg):	48.8	41.5	7.3	74.5
NOx (kg):	24.9	21.2	3.7	74.7
Distil. Oil:				
CO2 (kg):	20,310.7	17,771.9	2,538.8	50,776.8
SOx (kg):	28.0	24.5	3.5	70.0
NOx (kg):	16.8	14.7	2.1	42.0
Natural Gas:				
CO2 (kg):	15,843.0	13,202.5	2,640.5	52,810.0
SOx (kg):	0.1	0.1	0.0	0.3
NOx (kg):	12.0	10.0	2.0	40.0
Total:				
CO2 (kg):	41,962.6	35,911.9	6,050.7	121,013.4
SOx (kg):	76.9	66.1	10.8	144.7
NOx (kg):	53.7	45.9	7.8	156.7

1.2 Organization

The remainder of this EMISS user's guide is organized as follows: Section 2 provides instructions for installing the program so that it can be used with BLCC. Section 3 explains the usage of the EMISS program, both in creating new emission factor files and modifying existing files. Section 4 documents the equations used to generate specific emission factors and the data contained in EMISS.FIL, the default database file. Appendix A provides documentation of EMISS.FIL.

2. Installing EMISS

EMISS is intended for installation and use on IBM-PC or compatible microcomputers operating under DOS (or in a DOS shell from the Microsoft Windows environment). The program is small enough to operate under normal memory conditions. Like BLCC, EMISS should be installed to a hard disk in the same subdirectory as the NIST BLCC program (version BLCC 4.3-95 or later). It is assumed that you have already installed BLCC and its supporting files to your hard disk since the primary purpose of the EMISS program is to generate data files to support BLCC analyses. However, BLCC does not need to be physically present in the same subdirectory for the EMISS program to operate properly.

To install EMISS, make the BLCC subdirectory the current drive, then insert the EMISS distribution disk in your A or B "floppy" drive, the source drive. Now enter "COPY A:*.*" or "COPY B:*.*", where A or B is the source drive designator. The two files that must be copied to the BLCC subdirectory are EMISS.EXE and EMISS.FIL. EMISS.EXE is the executable program file. EMISS.FIL is the default data base file. Once these two files are in the BLCC directory, the EMISS program is ready to run.

3. Running EMISS

To start the program, type "EMISS" at the DOS ready prompt. The first screen contains information about the program and the main menu, as shown in screen 3-1.

```
EMISS: Air Pollution Emission Factor Calculations, version 1.00
      (Emission factors for use with the NIST BLCC program)

                          Main Menu

              Create new emission factor file
              Edit existing emission factor file
              General Information
              eXit

           Use     to make selection, then press <Enter>.
                 (or press highlighted character)


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```

Screen 3-1. Opening Screen with Main Menu

3.1 The Main Menu

There are four menu choices on the main menu which can be executed by using the cursor keys ( ) to highlight your choice and then pressing <Enter>, or by pressing the highlighted character of the desired menu item (C, E, G, or X). At the bottom of the screen you will see an additional message with a slightly expanded definition of the currently highlighted menu choice. If you create a new emission factor file, you will have two choices: (1) generate emission factors from location-specific data related to fuels used at the building site (e.g., energy and sulfur content), most of which have default values taken from EMISS.FIL; or (2) enter the emission factors directly.

If you are editing an existing data file, you can only change the emission factors themselves, not the underlying data used to generate the file. Since the emission factors can be edited, there is no method for assuring that the original input data corresponds to the emission factors in the file. Thus the underlying input data used to generate emission factors for the fossil fuels are not saved in the output file and cannot be retrieved once you save the emission factors file.

3.2 Creating a New File

To create a new emission factor file, choose the first menu selection, "Create new emission factors file." A second menu will then appear, with two choices as shown in screen 3-2. If you choose "Generate new emission factors based on local data," a series of data entry screens must be completed to generate the factors. These data entry screens require user responses related to the location of the electric utility, SO_2 scalars for electricity, sulfur and energy content of fossil fuels used at the building site, and the type of end-use equipment. Default data are provided for the SO_2 scalars and for the sulfur and heating values of each fossil fuel used at the building site. These default factors, as well as the parameters used to generate the emission factors themselves, are taken from the data base file (EMISS.FIL). Default values for fossil fuels are based on national average values.

If you choose "Enter new emission factors directly", you will be able to enter appropriate emission factors for each fuel type into a screen array provided for this purpose. For instructions on entering emission factors directly, skip to section 3.6.

```
Create new emission factor file

Generate new emission factors based on local data
Enter new emission factors directly
```

Screen 3-2 Declare use of default data

3.3 Generating Emission Factors

With EMISS you can generate a data file with location-specific emission factors for up to six different end-use fuel types. Screen 3-3 shows the display of available fuel types and preliminary instructions for including them in the emissions file. This screen is displayed immediately after you elect to generate new emission factors. You must "tag" each of the relevant fuel types by using the cursor keys ( ) to highlight the fuel type, and then pressing the space bar to toggle the selection on. Press the space bar again to toggle the selection off. The fuel type name is displayed in red when it is selected for inclusion; in white when it is unselected. You must select at least one fuel type. Press <Enter> when all of the desired fuel types have been selected.

Screen 3-4 shows additional instructions that are displayed to the screen after selection of fuel types has been completed. The information on this screen is determined to some extent by which fuel types have been selected. For example, the information on generating emission factors for electricity will only be displayed if you selected electricity in the previous screen.

```
Select the end-use fuel types for which
you wish to generate emission factors:

Electricity         Use the up and down arrows to highlight fuel names.
Coal                Tag the fuel types for which you wish to generate
Distillate Oil      emission factors by pressing the space bar on the
Residual Oil        highlighted name. The space bar toggles the
Natural Gas         selection on and off.  Press <Enter> when you have
LPG                 completed your selection. Press <Esc> to back up.

     Note: the fossil fuel types shown here are for end-use at
     the building site, not for remote electricity generation.
```

Screen 3-3. Selection of fuel types for generation of emission factors

```
                Instructions for generating emission factors

For electricity, when you choose a specific region, state, or U.S. average,
corresponding emission factors will be read from the EMISS data base file.

For fossil fuels, specific data related to sulfur content, heating value
and end-use for each fuel are required in order to calculate local emission
factors. Default values are provided for sulfur content and heating value.
Choose the end-use combustion process most typical for the buildings to be
evaluated. The combustion process is used only to estimate NOx emission
factors.

After this information is entered, the complete array of emission factors
will be displayed and you will be able to edit and/or save this file.
```

Screen 3-4. Instructions displayed before data entry for individual fuel types

There are two data entry formats that you will encounter when you enter the information needed to generate local emission factors for the selected fuel types: (1) data fields requiring the user to enter numeric values, and (2) a menu of choices from which you can select a single alternative. The method for generating electricity emission factors is different than the method for generating fossil-fuel emission factors. For electricity, precalculated emission factors are retrieved directly from the EMISS.FIL data base, based on the region or state that best represents the location of the building. For fossil fuels consumed at the building site, emission factors are calculated from fuel-specific data that represents their end-use characteristics.

3.3.1 Emission Factors for Electricity

The first step required to generate emission factors for electricity is to choose the location from available regions and states in the EMISS.FIL data file. Screen 3-5 shows the screen display with the names of regions and states with available electricity emission factors. Use the cursor arrows to highlight your selection and press <Enter>. When you select the region or state, the corresponding emission factors for CO_2, SO_2, and NO_x will be retrieved from the EMISS.FIL data base. The factors retrieved are shown in table 4.2 in section 4 of this report. Note that Alaska, Rhode Island, Vermont, and Washington, D.C., do not have a complete set of emission factors. In these locations it may be better to use regional factors than state-specific factors. All emission factors can be edited (if desired) when data entry is completed for all fuels and the complete array of emission factors is displayed. (See section 3.5.)

```
                Choose location for electricity emission factors:

New England                Missouri                Louisiana
   Connecticut             Nebraska                Oklahoma
   Maine                   North Dakota            Texas
   Massachusetts           South Dakota         Mountain
   New Hampshire        South Atlantic             Arizona
   Rhode Island            Delaware                Colorado
   Vermont                 District of Columbia    Idaho
Middle Atlantic            Florida                 Montana
   New Jersey              Georgia                 Nevada
   New York                Maryland                New Mexico
   Pennsylvania            North Carolina          Utah
East North Central         South Carolina          Wyoming
   Illinois                Virginia             Pacific
   Indiana                 West Virginia           California
   Michigan             East South Central         Oregon
   Ohio                    Alabama                 Washington
   Wisconsin               Kentucky             Pacific Noncontiguous
West North Central         Mississippi             Alaska
   Iowa                    Tennessee               Hawaii
   Kansas               West South Central      U.S. Average
   Minnesota               Arkansas
```

Screen 3-5. Regions with default electricity emission factors

After you select the region or state, you must enter SO_2 scalars for each year between the declared base year and the year 2010. These scalars represent the anticipated reduction in SO_2 emissions per kWh generated as a result of increasing environmental controls on electricity generation through the year 2010. Default data for these scalars are retrieved from EMISS.FIL. A scalar (or index) value of 1.0 represents 100% of the SO_2 emission factor for electricity and is applied to the base year, 0.9 represents 90% of that value, etc. The base year is entered in the data entry field shown in screen 3-6. The default value is 1993, since that is the year in which the default data in EMISS.FIL are based. If you intend to use the default SO_2 scalar data, you should use the default base year, even if you are going to use the emissions data for projects starting in subsequent years.

```
                    SO2 Scalars for Electricity

SO2 scalars are used to reflect scheduled reductions in SO2
emissions from the generation of electricity, by year. The scalar
for the base year is set to 1.0; scalars are set to some fraction
of 1.0 for the years following. Default data for these scalars
are read from the EMISS data base file specific to the region or
state selected for the electricity factors.

    First enter the base year for SO2 scalars (1993-1999): 1993


       The base year for the default EMISS data is 1993.
```

Screen 3-6. Base year for SO_2 scalars

Screen 3-7 shows the data entry form used to enter the SO_2 scalars. The scalars should correspond to the years shown on the left side of the form. The first year is the declared base year. The factor for the base year is usually 1.0. The form allows entries for up to 20 factors. The factors must fall in the range 0.1 to 1.25. However, any factor left as zero will cause BLCC to use the last non-zero factor when calculating SO_2 emissions for years beyond that last year. For example, in the file generated from the data shown in screen 3-7, the last scalar before a zero is 0.41 in 2010. When using this file, BLCC will set the SO_2 scalar for the year 2011 and all later years to 0.41.

```
                        SO2 Scalars by Year
Year
1993     1.00       SO2 scalars are used to adjust the SO2 factor for
1994     .93        electricity (included in the emissions factor table) to
1995     .86        account for the impact of expected regulations and
1996     .79        changes in fuel mix.
1997     .73
1998     .66        Scalar for base year (1993) must = 1.00
1999     .59        Other scalars must be in range 0.1 - 1.25, or 0.
2000     .52        In BLCC, scalar for all years in which 0 is entered
2001     .5         will repeat last non-zero entry.
2002     .48
2003     .47        Press <Enter> after entering each scalar;
2004     .45        use up and down arrows to move from field to field.
2005     .43        Press <PgDn> when scalars are entered correctly.
2006     .43
2007     .42
2008     .42
2009     .41
2010     .41
2011     0.00
2012     0.00
```

Screen 3-7. SO_2 scalars by year

The remaining input data for generating emission factors are related to fossil fuels consumed directly at the building site: coal, distillate and residual fuel oils, natural gas, and LPG.

3.3.2 Emission Factors for Coal

Coal-related emission factors vary with the proportion of bituminous, subbituminous, and lignite coal fired at the site, the sulfur content (percent by weight) of each of these three coal types, their energy content in MJ/kg (10^6 joules per kilogram), and the type of end-use combustion equipment typical of the location to be represented. Screen 3-8 shows the first data entry screen for coal. First enter the percent of bituminous coal usage at the site to total coal usage at the site. (Enter as a percent, not as a ratio; that is, 22.5% is entered as 22.5. Only two decimals to the right of the decimal are retained. Remember, this percentage is for coal usage at the site, not coal used centrally to generate electricity.) Then enter the percent of subbituminous coal usage to total coal usage at the site. The percent of lignite used at the site is automatically computed by subtracting the sum of the bituminous and subbituminous coal usage from 100. (You cannot enter a percentage value for lignite directly.)

The sulfur and heating values will only be requested for those coal types which have non-zero percent usage. Default values for the sulfur content and heating value of each coal type will be shown in the appropriate data field. Press <Enter> to accept any default choice, or enter your own value and then press <Enter>. The allowable range for each variable is shown with its data entry field.

```
            Emission factors for Coal usage (at building site)

        Coal usage can be BITUMINOUS, SUBBITUMINOUS and/or LIGNITE.
            Emission factors will be weighted proportionally.

Enter percent of bituminous coal usage to total coal usage (0-100): 25
Enter percent of subbituminous coal usage to total coal usage (0-100): 25
Percent of lignite usage to total coal usage =  50

Heating value for bituminous coal in MJ/kg (20-40): 30.5
Approximate percent of sulfur in bituminous coal (.01-5): 2.1

Heating value for subbituminous coal in MJ/kg (15-35): 20.4
Enter approximate percentage of sulfur in subbituminous coal (.01-5): 1

Heating value for lignite coal in MJ/kg (10-30): 16.1
Enter approximate percentage of sulfur in lignite (.01-5): 1
```

Screen 3-8. Input data needed to generate coal emission factors

Screen 3-9 shows the menu used to select the end-use equipment for coal use at the building site. The equipment selected is used to generate the NO_x emission factor for coal. Highlight your choice and press <Enter>.

```
                Coal-fired end-use equipment

          Choose most appropriate end use for this fuel

        Pulverized coal fired, Dry bottom
        Pulverized coal fired, Wet bottom
        Cyclone furnace
        Spreader stoker
        Overfeed stoker
        Underfeed stoker
        Handfired units
```

Screen 3-9. Selecting the most appropriate end-use combustion equipment for coal

3.3.3 Emission Factors for Distillate Fuel Oil

Screen 3-10 shows the data entry screen for use with distillate fuel oil. The sulfur content (percent by weight) and energy content in MJ/liter (10^6 joules per liter) of this fuel, as delivered to the building site, and its typical end-use equipment, are needed to generate emission factors for distillate fuel oil. Default data for the sulfur and energy contents are retrieved from EMISS.FIL. The allowable range for each variable is shown with its data entry field.

```
      Factors for Distillate Oil usage (at building site)

        Heating value in MJ/liter (35 to 50): 42.3
        Approximate percentage of sulfur (0.0-5.0): .21


            Choose most appropriate end use for this fuel

             Industrial/Comm boilers
             Residential Furnaces
```

Screen 3-10. Input data needed to generate distillate oil emission factors

3.3.4 Emission Factors for Residual Fuel Oil

Screen 3-11 shows the data entry screen for use with residual fuel oil. The sulfur content (percent by weight) and energy content in MJ/liter (10^6 joules per liter) of this fuel, as delivered to the building site, and its typical end-use equipment, are needed to generate emission factors for residual fuel oil. Default data for the sulfur and energy contents are retrieved from EMISS.FIL. The allowable range for each variable is shown with its data entry field.

```
Factors for Residual Oil usage (at building site)

    Heating value in MJ/liter (35 to 50): 40.6
    Approximate percentage of sulfur (0.0-5.0): .83

  Choose most appropriate end use for this fuel

 Industrial/Comm Boilers
 Utility Boilers
```

Screen 3-11. Input data needed to generate residual oil emission factors

3.3.5 Emission Factors for Natural Gas

Screen 3-12 shows the data entry screen for use with natural gas. The sulfur content (percent by weight) and energy content in MJ/m^3 (10^6 joules per cubic meter) of this fuel, as delivered to the building site, and its typical end-use equipment, are needed to generate emission factors. Default data for the sulfur and energy contents are retrieved from EMISS.FIL.

3.3.6 Emission Factors for LPG

Screen 3-13 shows the data entry screen for use with LPG. The sulfur content (percent by weight) and energy content in MJ/liter (10^6 joules per liter) of this fuel, as delivered to the building site, and its typical end-use equipment, are needed to generate emission factors for LPG. Default data for the sulfur and energy contents are retrieved from EMISS.FIL. The allowable range for each variable is shown with its data entry field.

```
Factors for Natural Gas usage (at building site)

    Heating value content in MJ/m3 (25 to 45): 38.4
    Approximate percentage of sulfur (0.0-5.0): .0006

  Choose most appropriate end use for this fuel

 Industrial Boilers, uncontrolled
 Industrial Boilers, controlled-low NOx burners
 Industrial Boilers, controlled-flue gas recirc
 Commercial Boilers, uncontrolled
 Commercial Boilers, controlled-low NOx burners
 Commercial Boilers, controlled-flue gas recirc
 Residential Furnaces
```

Screen 3-12. Input data needed to generate natural gas emission factors

```
    Factors for LPG usage (at building site)

   Heating value in MJ/liter (15 to 30): 22.9
   Approximate percentage of sulfur (0.0-5.0): .0006

  Choose most appropriate end use for this fuel

 Industrial Boilers
 Commercial Boilers
 Residential Furnace
```

Screen 3-13. Input data needed to generate LPG emission factors

3.4 File Name and Documentation Data

After the appropriate data entries shown in screens 3-6 through 3-13 have been entered, the emission factors are generated automatically. However, before these factors are displayed to the screen, the name of the data file to which they will be saved and certain documentation data must be entered. If you chose to enter the emission factors directly from the menu shown in screen 3-2, you start by entering the file name and documentation data. The file name of the data file to which these factors should be saved is entered into a data entry field provided at this time. Use standard DOS-compatible file names (eight characters maximum, no spaces). Do not enter the file name extension; this is automatically provided by the program. Extension EMI is added by EMISS to designate emission files; BLCC looks for this file name extension when accessing emission factor files.

Screen 3-14 shows additional documentation data needed before the emission factors are displayed. The region and source data entered here are stored with the file but are not actually used by BLCC. However, the units designator is actually used in BLCC because it determines the units used in generating and saving the emission factors. Enter "B" for kilograms per million Btu (kg/MBtu) or "J"

for kilograms per billion joules (kg/GJ). No other characters can be entered here. Note that BLCC can accept emission factors in either conventional or SI units. If you change the units designation in EMISS the emission factors will be converted and saved accordingly. If you designate "B" the BLCC emission calculations will be reported in kg/MBtu; if you designate "J" the BLCC calculations will be reported in kg/GJ.

Once you have completed the entries on the documentation screen, press <PgDn> to continue. You can also return to your data input screens by pressing the escape key, <Esc>.

```
      Enter the following documentation variables:

Location: _____________________
Source Documentation: _____________________
Units (B = kg/MBtu; J = kg/GJ): J
```

Screen 3-14. Documentation data

3.5 The Emission Factors Screen

Once the documentation data has been completed, the emission factors are automatically generated and displayed to the screen in an array for review and editing, if required. Screen 3-15 shows the the display of emission factors resulting from your input data. Any factor can be edited by moving the cursor to the appropriate field, typing in a new value, and pressing <Enter>. Press <PgDn> when this screen is completed, or press <Esc> to return to the previous screen. You can return to the data input screens to review the input data used to generate these factors by pressing <Esc> until you reach the appropriate screen. However, if you have changed any of the emission factors on the emission factors screen, these changes will not be preserved once you move back to the data input screens. Instead, the emission factors will be recalculated as you move from the data entry screens to the emission factor screen again. Once you save the emission factor file, the input data that you used to generate this file is no longer available, since there is no way to know if the emissions data in the file was edited before it was saved.

If you chose the option to enter emission factors directly when you were at screen 3-2, the data fields in the emission factors screen will be blank. You only need to enter factors for fuels that are relevant to the BLCC analyses you will be conducting.

```
            Calculated emission factors based on your responses.
              Factors can be edited further here if desired.

                        Emission Factors by Energy Type (kg/GJ)
            ------------------------------------------------------------------
Emissions     Electri-  Distillate  Residual    Natural      LPG        Coal
  Type          city        Oil        Oil        Gas
---------
  CO2         269.215    68.78      74.58      50.06      59.45      90.8125
  SO2         2          .1033      .3727      .0002      .0003      1.00755
  NOx         .811       .062       .162       .059       .0901      .07725

                Press <PgDn> when data entry is completed.
                Press <Esc> to return to previous screen.
```

Screen 3-15. Emission Factors generated from user input

3.6 Entering Emission Factors Directly into EMISS

A new emission factors data file can also be set up directly in EMISS, without using end-use fuel characteristics to generate the factors. From the menu shown in Screen 3-2 choose "Enter new emission factors directly". Enter the file name to be given to this file in the field provided. Enter the documentation data as shown in Screen 3-14, including the specification as to whether the factors will be in conventional or SI units. After the documentation form is completed, press <PgDn>. A blank data entry form similar to that shown in Screen 3-15 will be displayed. Enter the emission factors in the units declared in the documentation screen. Press <PgDn> when data entry is completed for the energy types of interest. Then enter the SO_2 scalars as shown in screens 3-6 and 3-7. (See the instructions for entering scalars in section 3.3.1.) Press <PgDn> when the scalars have been entered. At this point the new file will automatically be saved under the file name specified and control will be returned to the main menu.

3.7 Editing Emission Factors

You can edit existing emission factor files by choosing "Edit existing emission factor file" from the main menu. A list of existing emission factor files, all with the extension "EMI", will appear on the screen. Use the cursor to highlight the target file to be edited and press <Enter>. The documentation screen will be displayed as shown in Screen 3-14. You can change the emission factors from conventional units to SI units or the reverse by changing the units code in this screen. Press <PgDn> when you have completed the editing of the documentation data.

After the documentation data has been accepted, the emission factors in the file will be displayed to the screen for direct editing, as shown in Screen 3-15. (You cannot go back to the intermediate data that were used to generate these factors, if any, once you have saved this file.) Move the cursor to highlight the data entry field to be edited; change the value as required. Press <PgDn> when the editing of the emission factors is completed. The scalars for annual SO_2 emissions from electric power generation is displayed next, as shown in Screen 3-6 and 3-7. These factors can also be edited as required. Press <PgDn> when this data is correct. Finally, you will be asked to enter the file name for saving this

edited file. The default file name will be the same as the file name of the original file. If you do not wish to write over the original file you must change the file name. The three-letter extension "EMI" will automatically be tagged to the file name.

3.8 General Information

If you choose the "General information" option from the main menu, the messages shown in screen 3-16 will be displayed. Press any key to return to the main menu.

```
                    Notes on the EMISS program

EMISS creates or modifies local air polution emission factors for use
with the NIST BLCC computer program. BLCC produces estimates of
emissions related to energy use in buildings and the potential reduction
in those emissions attributable to energy conservation projects.

You can retrieve default emission factors from a data base provided with
this program and tailor these factors for regional or local use.
You can create new data files with emission factors from other sources,
or you can modify the emission factors in an existing data file.

Emission types are limited to CO2, SO2, and NOx.

Emission factors (in kg/MBtu or kg/GJ) can be generated for
electricity, coal, distillate oil, residual oil, natural gas, and LPG.
Note: MBtu = million Btu; GJ = gigajoule (billion joules).

The file of default data used to generate emission files is EMISS.FIL.
Emission files created by EMISS have the filename extension 'EMI'.
For more information on EMISS, see the EMISS user's guide, NISTIR 5704.
```

Screen 3-16. General information messages accessed from main menu

4. Documentation

4.1 Computation of Emission Factors Generated by EMISS

All air pollution emission factors generated by EMISS are based on kg/GJ at point of end use. Multiply these factors by the reduction in purchased electricity or fuel at the building site (in GJ) to estimate the reduction in emissions corresponding to the reduction in energy use.

Variables declaration:

EmFactor(e,f) = emission factor for emission type e, fuel f

Emission types (e= 1 to 3):
1=Carbon dioxide (CO_2) 2=Sulfur Dioxide (SO_2) 3=Nitrous Oxide (NO_x)

Fuel types (f = 1 to 9):

1=electricity	5=LPG
2=distillate oil	6=coal (general)
3=residual oil	7=bituminous coal
4=natural gas	8=subbituminous coal
	9=lignite

CO2(f) = CO_2 coefficient for fuel type f, in kg/GJ, based on reference energy content.
SOx(f) = SO_2 coefficient for fuel type f, per unit percent weight (SFactor(f)), in kg/GJ based on reference energy content.
SFactor(f) = Sulfur content of fuel type f by weight (entered by user).
NOx(f,k) = NO_x coefficient for fuel type f, end use k (of the n end uses available in EMISS.FIL for this fuel type), in kg/GJ, based on reference energy content.
FCref(f) = reference energy content of fuel type f (GJ/liter for oil and LPG; GJ/kg for coal; GJ/m^3 for natural gas).
FC(f) = actual energy content of fuel f (entered by user).

Coal(1) = ratio of bituminous coal to total coal use at site.
Coal(2) = ratio of subbituminous coal to total coal use at site.
Coal(3) = ratio of lignite coal to total coal use at site.

Note: coal emission factors are computed for coal (6, general) based on the mix of bituminous, subbituminous, and lignite coal use at the point of end use.

Computation of emission factors:

(1) Electricity

Emission factors taken directly from EMISS.FIL. See section 4.2 for derivation.

(2) Distillate Oil

EmFactor(1, 2) = CO2(2)
EmFactor(2, 2) = SOx(2) * SFactor(2) * FCref(2) / FC(2)
EmFactor(3, 2) = NOx(2, k) * FCref(2) / FC(2)

(3) Residual Oil

EmFactor(1, 3) = CO2(3)
EmFactor(2, 3) = SOx(3) * SFactor(3) * FCref(3) / FC(3)
EmFactor(3, 3) = NOx(3, k) * FCref(3) / FC(3)

(4) Natural Gas

EmFactor(1, 4) = CO2(4)
EmFactor(2, 4) = SOx(4) * SFactor(4) * FCref(4) / FC(4)
EmFactor(3, 4) = NOx(4, k) * FCref(4) / FC(4)

(5) LPG

EmFactor(1, 5) = CO2(5)
EmFactor(2, 5) = SOx(5) * SFactor(5) * FCref(5) / FC(5)
EmFactor(3, 5) = NOx(5, k) * FCref(5) / FC(5)

(6) Coal

```
EmFactor(1, 6) =   coal(1) * CO2(7)
                 +  coal(2) * CO2(8)
                 +  (1 - coal(1) - coal(2)) * CO2(9))

EmFactor(2, 6) =   coal(1) * SOx(7) * SFactor(7) * FCref(7) / FC(7)
                 +  coal(2) * SOx(8) * SFactor(8) * FCref(8) / FC(8)
                 +  (1 - coal(1) - coal(2)) * SOx(9) * SFactor(9) * FCref(9) / FC(9)

EmFactor(3, 6) =   coal(1) * NOx(7, k) * FCref(7) / FC(7)
                 +  coal(2) * NOx(8, k) * FCref(8) / FC(8)
                 +  (1 - coal(1) - coal(2)) * NOx(9, k)) * FCref(9) / FC(9)
```

4.2 Methodology for Estimating Reductions in Air Pollution Emissions from Electric Utilities

4.2.1 Emission Factors

Traditional methods of estimating reductions in air pollution emissions (CO_2, SO_2, and NO_x) related to reductions in electricity usage have been based on the average mix of generation units at the national, regional, or state level.[1] However, reductions in electricity usage due to conservation efforts will not result in equal reductions in the output of all generating units and therefore we would not expect that "average" emission factors would be a good indicator of actual emission reductions from these conservation efforts. Non-fossil generating capacity (mostly nuclear and hydroelectric) will continue to be utilized at their current production rates, even after the conservation projects are implemented, since they have relatively low variable generating costs. Instead, the decreased usage of electricity due to conservation will primarily result in less usage of fossil-fired generating units, which have relatively high variable generating costs. Therefore, the reductions in emissions resulting from reductions in electricity usage should be based on the average emission rates from fossil-fired generating units rather than on the average emission rates from all generating units. (Ideally, the emissions from the actual units whose operation would be cut back should be estimated, but this requires a level of data and computational resources that is impractical at present.)

Two tables of national, regional, and state emission factors were developed to support the EMISS data base. Table 4-1 provides emission factors based on the average emissions per kWh (at the point of end use) from all generating units in the location indicated. Table 4-2 provides emission factors based on the average emissions per kWh from fossil-fired generating units only (coal, petroleum, and natural gas) in the locations indicated.[2] Since the total emissions used as the basis for computing both tables are the same, but the kWh output from fossil-fired units only is smaller than the total kWh production, the emission factors in Table 4-2 are significantly larger than in table 4-1. The emission factors shown in table 4-2 also show less variation than those in table 4-1 since the ratio of fossil-fired generating units to total generating units, which affects the coefficients in table 4-1 but not in table 4-2, varies significantly from state to state and region to region. It is recommended that the emission factors in table 4-2 be used in assessing reductions in emissions due to conservation efforts, while the emission factors in table 4-1 be used in estimating emissions related to the total electricity usage in federal (or other) buildings. Both of these tables are based on 1993 emissions estimates and electricity generation data from DOE/EIA's *Electric Power Annual, 1993* (DOE/EIA-0348(93), December, 1994). In both tables, net electricity generation reported for each region or state is adjusted downward to reflect transmission/distribution losses of 9% before it was used to calculate the emissions per unit at end use.[3] Actual kWh sales by state or region are not used for calculating corresponding emission factors

[1] For example, Weisberg, P., *Green Lights Pollution Prevention Methodology*, ICF, Washington D.C., 1991; and Petersen, S., *Air Pollutant Emission Factors for Federal Energy Conservation Projects*, NISTIR-5508, NIST, Gaithersburg, MD, 1994.

[2] Electricity generation and corresponding emissions from nuclear, hydroelectric, and "other" generation categories reported in the *Electric Power Annual* were not used in calculating table 4-2. The "other" category includes some propane gas, methane, light oil, oil/coal mixtures, biomass, and renewable resources (photovoltaics, geothermal, and wind) which could not be further disaggregated.

[3] The *Electric Power Annual* states that transmission/distribution losses are approximately 8-9%. The higher value was used here since losses at the margin (i.e., for each additional kWh produced or saved) are higher than average losses.

because it is impossible to determine where or how these kWh were produced and they do not correspond to the emissions data as reported for specific regions and states.

The state and regional data in tables 4-1 and 4-2 should be used with caution, since the emission factors only pertain to electricity actually produced in that state or region. However, electricity usage at any given end-use location may be supplied by generating facilities in other states or regions. As the "wheeling" of electricity from greater distances becomes more commonplace it will become increasingly difficult to estimate air pollutant emissions related to electricity usage at a given site.

4.2.2 Computation of SO_2 Scalars

The BLCC program calculates the annual reduction in SO_2 emissions due to the electricity savings from energy conservation projects and sums these emissions over a designated study period (e.g., 25 years). To accomplish this, BLCC applies yearly SO_2 scalars to the nominal SO_2 emission factor for the location specified (i.e., the SO_2 emission factor from table 4-2). The SO_2 scalars represent the anticipated reduction in SO_2 emissions per kWh produced, by year, from fossil-fired power plants as a result of increasing environmental controls through the year 2010. Default data for these scalars have been computed from DOE/EIA projections and are contained in the EMISS.FIL. The methodology for the computation of these factors is reported here. The data used for this purpose are derived primarily from the "Supplement to the *Annual Energy Outlook*[4]." The methodology described here is for the overall United States. Projections of regional SO_2 emissions in the *Supplement* are based on North American Electric Reliability Councils (NERC) regions. A list of the 13 NERC regions, along with the states in each NERC, is shown in table 4-3. (Each state is assigned to only one NERC region; where NERC regions cross state boundaries, the predominant NERC in the state determines which NERC a state is assigned to in this list.) These NERC regions do not correspond to the 9 census regions used to generate the emission factors shown in tables 4-1 and 4-2. Table 4-4 shows these census regions and the NERC region(s) that are partially or fully located within. The adjustments made to map the NERC-based SO_2 scalars to the states and census regions are as follows:

SO_2 emissions are reported in the *Supplement* only for the years 1993, 2000, 2005, and 2010. Total SO_2 emissions for electricity generation in the United States and in each NERC region in each of these years is divided by the corresponding sum of electricity generation by coal, petroleum, and natural gas (the primary contributors to SO_2 emissions) for those same years to arrive at unit SO_2 emissions. (The units are irrelevant here since the data are used to derive non-dimensional scalars.) A small amount of renewable generating capacity (e.g., wood and other biomass) may involve SO_2 emissions; these could not be identified sufficiently for inclusion in this analysis. The year 1993 is designated as the base year; the unit SO_2 emissions for each of the four years are divided by unit SO_2 emission for 1993, resulting in a scalar value of 1.0 for 1993 and smaller scalars for the remaining three years. The scalars for the four years are then linearly interpolated to derive scalars for the intermediate years.

The SO_2 scalar sets for the individual NERCs are assigned to each of the states within that NERC. States which are located in more than one NERC are assigned to the scalar set from the predominant NERC in that state. The census regions themselves have also been assigned a set of SO_2 scalars in the

[4] Energy Information Administration, "Supplement to the *Annual Energy Outlook 1995*," U.S. Department of Energy, DOE/EIA-0554(95), Washington, D.C., February 1995.

EMISS.FIL data file. For census regions which are dominated by a single NERC, the SO_2 scalars for that NERC are assigned to the census region. For census regions which include more than one NERC, a separate set of scalars was calculated as follows. The SO_2 emissions and corresponding fossil-fuel electricity generation for each NERC in the region are multiplied by the ratio of SO_2 contributions of the census-region states in that NERC to the total SO_2 emissions for that NERC for 1993. (SO_2 contributions by state for 1993 are taken from the *Electric Power Annual 1993*,[5] table 46.) These adjusted SO_2 emissions for each NERC in the census region were then summed and divided by the sum of adjusted fossil-fuel generated kWh for each NERC in the region to derive scalars for 1993, 2000, 2005, and 2010. The same adjustment ratios were used for all four years since no SO_2 projections by state are available. Linear interpolation was used to generate scalars for the intermediate years.

There are a total of 20 scalar sets, one for the overall United States, one for each of the 13 NERCs in the United States, and 6 based on combined NERCs within census regions. There are no SO_2 scalars for Alaska, Hawaii, or the "Pacific non-contiguous" region composed of those two states. By default, the United States average will be used. In the EMISS.FIL data base, an SO_2 scalar index value of 0 is used to indicate the scalar set for U.S. average. The indexing of SO_2 scalar sets to individual states (indices 1-13) is based on the NERC number shown in table 4-3. The indexing of the 6 SO_2 scalar sets for census regions with multiple NERC regions (indices 14-19) is shown in table 4-4.

[5] Energy Information Administration, *Electric Power Annual 1993*, DOE/EIA-0348(93), U.S. Department of Energy, December 1994, Washington, D.C. 20585.

Table 4-1 Emission factors based on all electrical generation

Region State	CO2 (kg/kWh)	SO2 (g/kWh)	NOx (g/kWh)
New England	0.374	2.697	0.879
Connecticut	0.229	0.972	0.382
Maine	0.091	0.741	0.123
Massachusetts	0.681	5.026	1.557
New Hampshire	0.324	3.486	1.230
Rhode Island	0.923	n/a	n/a
Vermont	0.029	n/a	n/a
Middle Atlantic	0.529	4.780	1.319
New Jersey	0.254	1.745	0.989
New York	0.452	2.635	0.928
Pennsylvania	0.635	6.778	1.638
East North Central	0.771	9.061	2.839
Illinois	0.457	5.651	1.957
Indiana	1.088	12.019	4.079
Michigan	0.718	3.869	2.561
Ohio	0.945	15.893	3.168
Wisconsin	0.647	3.799	2.442
West North Central	0.876	4.652	3.000
Iowa	0.856	5.629	3.731
Kansas	0.897	1.915	3.037
Minnesota	0.822	2.127	2.827
Missouri	0.852	8.695	3.354
Nebraska	0.741	2.544	2.895
North Dakota	1.166	4.582	1.994
South Dakota	0.543	5.880	2.086
South Atlantic	0.663	5.801	1.798
Delaware	0.945	6.001	2.400
District of Columbia	1.156	5.303	n/a
Florida	0.720	4.982	2.000
Georgia	0.619	7.175	1.531
Maryland	0.670	6.167	1.742
North Carolina	0.664	4.729	1.865
South Carolina	0.358	2.348	0.910
Virginia	0.511	3.611	1.165
West Virginia	1.004	11.922	3.044
East South Central	0.818	8.551	2.507
Alabama	0.722	5.804	1.991
Kentucky	0.975	9.700	3.366
Mississippi	0.604	6.050	1.588
Tennessee	0.828	11.610	2.450
West South Central	0.762	1.987	2.217
Arkansas	0.563	1.624	1.546
Louisiana	0.645	1.999	2.049
Oklahoma	0.811	2.124	2.471
Texas	0.812	2.013	2.310
Mountain	0.805	1.771	2.033
Arizona	0.466	1.905	1.524
Colorado	1.001	2.531	3.050
Idaho	0.000	0.000	0.000
Montana	0.677	0.850	1.786
Nevada	1.010	2.666	2.465
New Mexico	1.057	2.039	3.444
Utah	0.989	0.924	1.281
Wyoming	1.041	1.936	2.085
Pacific	0.171	0.347	0.478
California	0.228	0.040	0.587
Oregon	0.090	0.318	0.318
Washington	0.124	0.833	0.393
Pacific Noncontiguous	0.444	1.963	0.841
Alaska	n/a	0.218	n/a
Hawaii	0.779	3.277	1.475
U.S. Average	0.673	4.991	2.024

n/a = unavailable or unreliable due to small numbers

Table 4-2 Emission factors based on fossil-fuel electrical generation only

Region State	CO2 (kg/kWh)	SO2 (g/kWh)	NOx (g/kWh)
New England	0.860	6.399	2.086
Connecticut	0.947	4.531	1.780
Maine	0.971	7.870	1.312
Massachusetts	0.801	5.941	1.841
New Hampshire	1.036	11.204	3.954
Rhode Island	0.923	n/a	n/a
Vermont	0.613	n/a	n/a
Middle Atlantic	0.968	8.747	2.414
New Jersey	0.920	6.312	3.577
New York	0.917	5.344	1.883
Pennsylvania	0.998	10.653	2.574
East North Central	1.037	12.207	3.824
Illinois	1.039	12.836	4.446
Indiana	1.093	12.073	4.098
Michigan	1.053	5.678	3.759
Ohio	1.020	17.213	3.431
Wisconsin	0.905	5.354	3.442
West North Central	1.120	5.978	3.855
Iowa	0.978	6.461	4.283
Kansas	1.146	2.446	3.878
Minnesota	1.175	3.131	4.163
Missouri	1.086	11.090	4.278
Nebraska	1.130	3.877	4.412
North Dakota	1.227	4.822	2.098
South Dakota	1.070	11.596	4.115
South Atlantic	0.948	8.302	2.574
Delaware	0.925	6.001	2.400
District of Columbia	1.114	5.303	n/a
Florida	0.884	6.123	2.458
Georgia	0.930	10.774	2.299
Maryland	0.984	9.081	2.566
North Carolina	0.986	7.020	2.768
South Carolina	1.011	6.634	2.572
Virginia	0.918	6.493	2.096
West Virginia	1.009	11.983	3.059
East South Central	0.999	10.442	3.062
Alabama	1.010	8.122	2.786
Kentucky	1.013	10.074	3.496
Mississippi	0.916	9.169	2.406
Tennessee	0.990	13.877	2.928
West South Central	0.876	2.283	2.548
Arkansas	1.069	3.087	2.938
Louisiana	0.851	2.639	2.705
Oklahoma	0.889	2.329	2.710
Texas	0.862	2.137	2.453
Mountain	1.019	2.242	2.574
Arizona	0.815	3.327	2.662
Colorado	1.061	2.684	3.234
Idaho	0.000	0.000	0.000
Montana	1.149	1.443	3.030
Nevada	1.121	2.958	2.735
New Mexico	1.068	2.060	3.481
Utah	1.018	0.951	1.319
Wyoming	1.062	1.975	2.127
Pacific	0.668	1.377	1.899
California	0.591	0.103	1.521
Oregon	0.705	2.482	2.482
Washington	1.052	7.538	3.553
Pacific Noncontiguous	0.507	2.239	0.960
Alaska	n/a	0.304	n/a
Hawaii	0.781	3.285	1.478
U.S. Average	0.969	7.202	2.920

n/a = unavailable or unreliable due to small numbers

Table 4-3. North American Electric Reliability Council (NERC) regions with corresponding states[a,b]

1. ECAR: East Central Area Reliability Coordination Agreement
   IN, KY, MI, OH, WV
2. ERCOT: Electric Reliablity Council of Texas
   TX
3. MACC: Mid-Atlantic Area Council
   DC, DE, NJ, PA
4. MAIN: Mid-America Interconnected Network
   IL, WI
5. MAPP: Mid-Continent Area Power Pool
   IA, MN, NE, ND, SD
6. NPCC/NY: Northeast Power Coordinating Council/ New York
   NY
7. NPCC/NE: Northeast Power Coordinating Council/ New England
   CT, ME, MA, NH, RI, VT
8. SERC/FL: Southeastern Electric Reliability Council/ Florida
   FL
9. SERC/STV: Southeastern Electric Reliability Council/ excluding Florida
   AL, GA, MS, NC, SC, TN, VA
10. SPP: Southwest Power Pool
   AR, KS, LA, MO, OK
11. WSCC/NWP: Western Systems Coordinating Council/ Northwest Power Pool Area
   ID, MT, NV, OR, UT, WA
12. WSCC/RA: Western Systems Coordinating Council/ Rocky Mountain Power Area & Arizona
   AZ, CO, NM, WY
13. WSCC/CNV: Western Systems Coordinating Council/ California-Southern Nevada Power
   CA

[a] Alaska and Hawaii do not belong to a NERC region.
[b] The number of the NERC (1-13) is used as the index to locate the corresponding SO_2 scalar set in the EMISS.FIL data base.

Table 4-4. Census regions, SO_2 scalar set index[a], and corresponding NERC regions (with SO_2 prorating factors[b])

1. New England (7):
   NPCC/NE (100%)
2. Middle Atlantic (14):
   MACC (79%), NPCC/NY (100%)
3. East North Central (15):
   ECAR (69%), MAIN (100%)
4. West North Central (5):
   MAPP (100%)
5. South Atlantic (16):
   ECAR (16%), MACC (21%), SERC/FL (100%), SERC/STV (49%)
6. East South Central (9):
   SPP (100%)
7. West South Central (17):
   ERCOT (100%), SPP (35%)
8. Mountain (19):
   WSCC/NWP (55%), WSCC/RA (100%)
9. Pacific (18):
   WSCC/NWP (44%), WSCC/CNV (100%)

[a] The SO_2 scalar set index (in parentheses) locates the corresponding SO_2 scalar set in the EMISS.FIL data base.

[b] The NERC SO_2 prorating factor for a given census region represents the ratio of SO_2 emissions from states located in both the NERC and census region to the SO_2 emissions from all of the states located in that NERC. A factor of 100% implies that all of the states in the NERC are located in the census region. Source: See section 4.2.

Appendix A. Format of the EMISS.FIL data file

EMISS.FIL is a file of factors that is used by EMISS to provide default emission factors for electricity and fossil fuels consumed directly at the building site. In general, the EMISS user will not need to modify this file. However, it will be updated by NIST periodically as new data becomes available.

Note: any number of lines of header data can be included in this file. The EMISS computer program reads through this file until it encounters the first key word, "EMISSION_RECORDS". From that point it begins to read in data records for each fuel type in the following format:

line 1: key word

The following key words are used to denote the beginning of each record type:

1. ELECTRICITY
2. DISTILLATE OIL
3. RESIDUAL OIL
4. NATURAL GAS
5. LPG
6. BITUMINOUS COAL
7. SUBBITUMINOUS COAL
8. LIGNITE
9. SO_x SCALAR FACTORS

<u>For electricity (1):</u>

line 2: number of regions/states with records to follow.

line 3: dummy string used to identify data on line 4.

line 4: location, SO_2 scalar index, and three emission factors for CO_2, SO_2, NO_x.

The SO_2 scalar index indicates which set of regional SO_2 scalar factors (located at the end of this file) to use at this location.

<u>For fossil fuels (2-8):</u>

line 2: for fossil fuels: number of NO_x factors, SFactor, FCref for this fuel type.

line 3: dummy string used to identify data on line 4.

line 4: CO_2 and SO_2 factors.

The remaining lines in record provide a description of end-use combustion equipment and corresponding NO_x factor for this fuel type, one description and factor per line.

For SO_x scalars (9)

line 1: number of lines (sets) of SO_2 scalars in this file.

The remaining lines in this record provide the SO_2 scalars, as follows:
index, base year, number of years, scalar for each year.

Source of data in EMISS.FIL

Electricity emission factors: see section 4.2.1
Fossil fuels:
Sulfur content (weight percent, 1.0 = 1% sulfur by weight):
coal: *ASHRAE 1985 Handbook of Fundamentals*, Chapter 15, table 8.
natural gas: derived from EPA AP-42, *Compilation of Air Pollutant Emission Factors,* Table 1.4.2 "Emission Factors for SO_2, NO_x, and CO from Natural Gas Combustion."
distillate oil: *ASHRAE 1985 Handbook of Fundamentals*, Chapter 15, table 5.
residual oil: *ASHRAE 1985 Handbook of Fundamentals*, Chapter 15, table 5.
LPG: natural gas value used.
Heating value:
coal: *ASHRAE 1985 Handbook of Fundamentals*, Chapter 15, table 8.
natural gas: based on 1030 Btu/ft^3, DOE/EIA value.
distillate oil: *ASHRAE 1985 Handbook of Fundamentals*, Chapter 15, table 6.
residual oil: *ASHRAE 1985 Handbook of Fundamentals*, Chapter 15, table 6.
LPG: based on 91,547 Btu/gallon (propane) from table published by American Welding and Tank Co.